Industrial Hygiene Monitoring Results Dynamic Stripping Steam Injection Operations at Building 406 Gas Pad

Contents

Industrial Hygiene Monitoring Results Dynamic Stripping Steam Injection Operations at Building 406 Gas Pad

Industrial Hygienist:	James Martin, CIH
Facility:	Building 406
Date:	May 24 - June 24, 1993

GENERAL FINDINGS:

Air sample results from the Dynamic Stripping Steam Injection operations indicated airborne contaminant concentrations from the recovered gasoline product below applicable Federal Occupational Safety and Health Administration (OSHA) and American Conference of Governmental Industrial Hygienists (ACGIH) occupational exposure criteria. Air sample results were also below State of California OSHA (Cal/OSHA) occupational exposure criteria and ACGIH intended changes for Threshold Limit Values. General operational practices were observed to comply with OSHA and Operational Safety Procedure (OSP) requirements. Operational personnel were generally observed to work in a safe manner with attention to potential hazards, except as noted below.

The activities with the highest potential for personal exposure to organic contaminants include 1) when the system is open, especially at the Megator tank, and 2) in the event of a spill.

Continued use of personal protective equipment (PPE), as described in this report and in operational OSPs, is recommended based on 1) the air sampling results, 2) the potential for unexpected liquid splashes and/or airborne contaminant concentrations during maintenance or other open system operations, 3) the potential for gasoline spills, and 4) the recommended practice of maintaining personal exposures to carcinogens at levels "as low as reasonably achievable" (ACGIH). Particular diligence with PPE is necessary during operations involving concentrated gasoline such as at the Megator tank.

Several incidents of personnel failure to wear required PPE when working with and around the Megator tank were observed on July 7, 1993. Complacency with Gas Pad hazards may be a potential problem for ongoing and future Gas Pad operations. Periodic review of the required health and safety practices by project management personnel is strongly recommended.

Introduction

Industrial hygiene monitoring was performed at the Building 406 Gas Pad during Dynamic Stripping Steam Injection operations in order to characterize potential employee exposures. These operations were being performed to recover gasoline from the ground in the local area. The composition of the gasoline was expected to approximately consist of;

Contaminant	Percent	Vapor Pressure
• Benzene	10 %	75 mm Hg
• Toluene	11 %	20 mm Hg
• Ethylbenzene	05 %	10 mm Hg
• Xylenes	23 %	8 mm Hg
• Trichloroethylene (TCE)	0.9 %	58 mm Hg
• 1,2- Dichloroethane (1,2-DCA)	0.3 %	64 mm Hg
• Ethylene Dibromide (EDB)	0.06 %	12 mm Hg
• Other Fuel Hydrocarbons	50 %	---

Operational procedures are detailed in OSP 406.1, "Soil Vapor Tool Installation", OSP 406.4, "Treatment of Vapors and Ground Water Using Treatment Facility F (TFF)", and OSP L-52, "Cleanup of Ground Water Contaminated With Gasoline by Using the Dynamic Underground Stripping Process".

Industrial hygiene air sampling is required by OSHA regulations to evaluate workplace tasks which have the potential for employee exposure to exceed established Action Levels or Permissible Exposure Limits (PELs). Federal OSHA specifically regulates benzene as a carcinogen in 29 Code of Federal Regulations (CFR) Section 1910.1028. California OSHA also regulates ethylene dibromide as a carcinogen. Additional information regarding applicable occupational standards and guidelines is provided in this report.

Process Description

The general operational process is described in detail by existing procedures identified above and will not be repeated in this report except as necessary to explain the results of industrial hygiene sampling. A schematic system flowchart is provided as Appendix I for information.

Sampling and Analytical Methodologies

The air sampling strategy can best be described by three (3) rounds of sampling. The first round of sampling targeted short-term samples for benzene, toluene, ethylbenzene and xylenes (BTEX) due to 1) the relatively high composition of each in the recovered gasoline, 2) the relatively high vapor pressures of the selected contaminants, 3) the relative toxicity of each contaminant and (4) the likelihood that if any occupational standard would be approached it would be a short-term exposure rather than a full-shift (8-hour) exposure due to the system engineering controls. Round 2 sampling included sampling for ethylene dibromide due to ethylene dibromide's classification as a carcinogen by Cal/OSHA and as a suspect human carcinogen by the American Conference of Governmental Industrial Hygienists (ACGIH) and additional short-term samples for BTEX. Round 3 sampling focused on full-shift (8-hour) samples for BTEX and ethylene dibromide in order to document compliance with existing and proposed occupational exposure standards and guidelines.

Air sampling for BTEX was conducted in accordance with the National Institute for Occupational Safety and Health (NIOSH) Method 1501. Samples were collected by drawing air through solid sorbent tubes containing charcoal at flow rates of approximately 0.2 liters per minute (LPM) and 0.05 LPM. Two samples were collected concurrently with different air flow rates due to the initial uncertainty of the airborne organic concentrations and the concern that the samples at the higher air flow rate may have been overloaded if the actual airborne organic concentrations were high. Air sampling equipment was pre- and post-calibrated with a precision rotometer which had been calibrated against a primary standard. Samples were analyzed in accordance with NIOSH Method 1501 or equivalent.

Air sampling for ethylene dibromide was conducted in accordance with NIOSH Method 1008. This sampling method is essentially the same as described above for BTEX. Samples were analyzed in accordance with NIOSH Method 1008 or equivalent. The analytical procedures are different than required for BTEX analysis.

The air sampling described above is considered to be sufficient for documenting compliance with OSHA exposure limits for BTEX, ethylene dibromide and the contaminants not specifically sampled and analyzed including trichloroethylene, 1,2-dichloroethane and other fuel hydrocarbons. This determination is based on a professional evaluation of relative contaminant quantities in the gasoline, vapor pressures and relative occupational exposure limits.

Field measurements were also obtained using 1) an organic vapor monitor with a photoionization detector, 2) an organic vapor analyzer with a flame ionization detector, and 3) a combustible gas indicator. These measurements were performed as required by the applicable OSPs and as an immediate field indicator of airborne organic and combustible gas concentrations.

Results

Air sampling results are summarized in Tables 1 - 9. Laboratory analytical reports are provided as Appendix II.

Occupational Standards and Guidelines

Applicable occupational standards and guidelines are summarized in Table 10. LLNL policy is to comply with Federal OSHA standards and ACGIH guidelines as mandated by DOE Order 5480.10. State of California OSHA (Cal/OSHA) standards are also included in Table 10 due to the expectation that LLNL activities may be required to comply with Cal/OSHA standards within the next several years.

Discussion and Recommendations

Air Sample Results:

Air sample results from the Dynamic Stripping Steam Injection operations indicated airborne contaminant concentrations from the recovered gasoline product below applicable Fed/OSHA and ACGIH occupational exposure criteria. Air sample results were also below Cal/OSHA occupational exposure criteria and ACGIH intended changes for Threshold Limit Values. General operational practices were observed to comply with OSHA and OSP requirements. Operational personnel were generally observed to work in a safe manner with attention to potential hazards, except as noted below.

The most notable measured airborne contaminant concentrations (2.7 ppm benzene) were collected during VOA product sampling at the Megator tank when the tank lid was open for VOA sampling . Organic vapor monitor field measurements, indicated total hydrocarbon concentrations in the breathing zone of the sampling technician in the range of 50 - 350 ppm. Subsequent VOA sampling was performed without opening the Megator tank lid by inserting the VOA sampling tube through a small sampling port on the Megator tank lid. Measured airborne contaminant concentrations were significantly reduced by this VOA sampling method modification.

The activities with the highest potential for personal exposure to organic contaminants include 1) when the system is open, especially at the Megator tank and 2) in the event of a spill.

Personal Protective Equipment:

Personal protective equipment (PPE) requirements and practices are detailed in the applicable OSPs but generally included the following;

- Safety glasses and safety shoes required to enter the 406 Gas Pad area.
- Full-facepiece respirators with organic vapor cartridges, disposable (Tyvek®) coveralls and neoprene or nitrile rubber gloves required during system maintenance or other open system operations.

The hard hat requirement was discontinued as of May 26, 1993 due to the absence of any construction work.

Continued use of PPE as described above and in existing OSPs is recommended based on 1) the air sampling results, 2) the potential for unexpected liquid splashes and/or airborne contaminant concentrations during maintenance or other open system operations, 3) the potential for gasoline spills, and 4) the recommended practice of maintaining personal exposures to carcinogens at levels "as low as reasonably achievable" (ACGIH). Particular diligence with PPE is necessary during operations involving concentrated gasoline such as at the Megator tank.

Exceptions were made for PPE requirements under special circumstances. Camera crew personnel were allowed to film the inside of the Megator tank from an upwind position approximately ten (10) feet away without PPE. An organic vapor monitor was used to continually monitor the airborne hydrocarbon concentration at the camera man's position, the tank lid was only kept open approximately 15 seconds to allow for the filming, and the tank lid was kept closed before and after the filming. This practice is considered acceptable under similar circumstances such as for tank contents inspection so long as personnel without PPE do not get closer than four (4) feet of the open Megator tank at an upwind location. No one should be allowed downwind of the open Megator tank within the regulated (posted) area without the required PPE. E S & H personnel should continue to be notified in advance for assistance with such special circumstances, except in the event of a threat to life or property.

Incidents of July 7, 1993:

In the course of performing air sampling on July 7, 1993, E S &H personnel observed several operational personnel inspecting the Megator tank at 2:45 p.m. with the lid open and no PPE as described above. Personnel were reported to include William Siegel, Everett Sorensen and Albert Van Noy. One employee was observed with his head inside the tank opening without respiratory protection. It is understood that there was a problem associated with the tank and that the tank may not have contained a large quantity of gasoline. Unfortunately, even a small quantity of gasoline in the Megator tank will generate airborne organic concentrations inside the tank well in excess of occupational standards due to the volatile nature of gasoline constituents and the tendency of gasoline to layer on top of water. These personnel were reminded of the need for PPE.

The same incident was observed again at 3:30 p.m. on the same day. E S & H personnel repeated the reminder of the need for PPE.

The Team 4 Industrial Hygienist (James Martin) met with Gas Pad personnel on July 8, 1993 to discuss the observed incidents as well as the recent air sampling results. The hazards of gasoline constituents, and PPE requirements and rationale were reviewed. The particular need for attention to industrial hygiene requirements when working with and around the Megator tank were discussed. Complacency with Gas Pad hazards may be a potential problem for ongoing and future Gas Pad operations. Periodic review of the required health and safety practices by project management personnel is strongly recommended.

It should be further noted that OSHA regulations prohibit the use of a full-facepiece respirator with organic cartridges in an environment which may contain more than 50 ppm benzene (29 CFR 1910.1028). The organic cartridges may become overloaded and ineffective within a short period of time due to the very high organic concentrations within the tank area. Supplied air respiratory protection or self-contained breathing apparatus may be necessary for OSHA compliance if it is necessary for any personnel to place their heads inside the Megator tank. Air monitoring of the actual tank concentrations would be necessary to completely evaluate the appropriate level of respiratory protection.

TABLE 1

AIR SAMPLING RESULTS
DYNAMIC STRIPPING STEAM INJECTION OPERATIONS

Date: May 24, 1993

Sample No.	Employee Name/No.	Task	Time (min.)	Volume (liters)	Result (parts per million, ppm)				
					Benzene	Toluene	Ethyl benzene	Xylenes	Ethylene Dibromide
146170	Bunsen Nie 40A043	Sampled vapor from IC Unit Inlet (TFF-ICE-IN)	44	8.8	N/A[1]	N/A	N/A	N/A	—
146171			44	2.2	<0.2[2]	<0.2	N/A	<0.2	—
146176	Field Blank	—	—	—	< 3 µg[3]	< 3 µg	N/A	< 3 µg	—

[1] Not Available - Analysis not performed due to laboratory error
[2] < = Less than; Below the reliable limit of detection
[3] µg = micrograms

TABLE 2

AIR SAMPLING RESULTS
DYNAMIC STRIPPING STEAM INJECTION OPERATIONS

Date: May 25, 1993

Sample No.	Employee Name/No.	Task	Time (min.)	Volume (liters)	Result (parts per million, ppm)				
					Benzene	Toluene	Ethyl benzene	Xylenes	Ethylene Dibromide
146172	Bunsen Nie 40A043	Sampled vapor from IC Unit Inlet (TFF-ICE-IN) and Outlet (TFF-ICE-OUT)	30	6.0	<0.2	<0.1	N/A	<0.1	—
146173			30	1.5	<0.3	<0.3	N/A	<0.2	—
146174	Ben Johnson 443784	Collected 3 VOA samples from Megator	7	1.4	N/A	N/A	N/A	N/A	—
146175			7	0.4	2.7	<1.1	N/A	<1.0	—
146176	Field Blank	—	—	—	< 3 µg	< 3 µg	N/A	< 3 µg	—

TABLE 3

AIR SAMPLING RESULTS
DYNAMIC STRIPPING STEAM INJECTION OPERATIONS

Date: May 26, 1993

Sample No.	Employee Name/No.	Task	Time (min.)	Volume (liters)	Result (parts per million, ppm)				
					Benzene	Toluene	Ethyl benzene	Xylenes	Ethylene Dibromide
146177	Albert Van Noy 915062	Attempted "blow-out ofwell at SW corner of Pad (TLT-GP-001)	18	3.6	<0.3	<0.2	N/A	<0.2	—
146178			18	0.9	<0.5	<0.4	N/A	<0.4	—
146179	Bunsen Nie 40A043	Sampled vapor from ICE Inlet and Outlet	42	8.4	<0.1	<0.1	N/A	<0.1	—
146180			42	2.1	<0.2	<0.2	N/A	<0.2	—
146181	Ben Johnson 443784	Pumped gasoline from Megator to storage container for disposal	18	3.6	<1.1	<1.4	N/A	<0.2	—
148182			18	0.9	<0.5	1.1	N/A	<0.4	—
148183	Field Blank	—	—	—	< 3 µg	< 3 µg	N/A	< 3 µg	—

TABLE 4

AIR SAMPLING RESULTS
DYNAMIC STRIPPING STEAM INJECTION OPERATIONS

Date: May 27, 1993

Sample No.	Employee Name/ND	Task	Time (min.)	Volume (liters)	Result (parts per million, ppm)				
					Benzene	Toluene	Ethyl benzene	Xylenes	Ethylene Dibromide
146184	Ben Johnson 443784	Collected 2 VOA samples from Megator	13	2.6	<0.4	<0.3	N/A	<0.3	—
146185			13	0.6	<0.7	<0.6	N/A	<0.5	—
148183	Field Blank	—	—	—	< 3 µg	< 3 µg	N/A	< 3 µg	

TABLE 5

AIR SAMPLING RESULTS
DYNAMIC STRIPPING STEAM INJECTION OPERATIONS

Date: June 1, 1993

Sample No.	Employee Name/No.	Task	Time (min.)	Volume (liters)	Result (parts per million, ppm)				
					Benzene	Toluene	Ethyl benzene	Xylenes	Ethylene Dibromide
146206	Ben Johnson 443784	Diversion Tank Change-over and VOA sample collection	15	2.9	—	—	—	—	<3 ppb[4]
146207			15	0.7	—	—	—	—	< 13 ppb
146208			15	2.7	<0.5	<0.4	N/A	<0.3	—
146209			15	0.7	<1.7	<1.4	N/A	<1.2	—
146210	Bunsen Nie 40A043 (morning)	Sampled vapor from ICE Inlet and Outlet, Carbon Filter Inlet and Outlet (TFF-CFI & TFF-CFO and Diversion Tank #3	45	9.0	—	—	—	—	3 ppb
146211			45	2.3	—	—	—	—	< 4 ppb
146212			45	8.6	<0.2	<0.1	N/A	<0.1	—
146213			45	2.2	<0.6	<0.5	N/A	<0.4	—

[4] ppb = parts per billion

TABLE 5 (Continued)

AIR SAMPLING RESULTS
DYNAMIC STRIPPING STEAM INJECTION OPERATIONS

Date: June 1, 1993

Sample No.	Employee Name/NI	Task	Time (min.)	Volume (liters)	Result (parts per million, ppm)				
					Benzene	Toluene	Ethyl benzene	Xylenes	Ethylene Dibromide
146202	Bunsen Nie 40A043 (afternoon)	Sampled vapor from UV Inlet (TFF-UVI), Water Separator (TFF-MEGA-AQ), and Sample Tanks (TFF-SEPI)	60	10.6	—	—	—	—	0.4 ppb
146203			60	2.8	—	—	—	—	< 3.2 ppb
146204			60	11.7	<0.09	<0.08	N/A	<0.07	—
146205			60	2.8	<0.4	<0.4	N/A	<0.3	—
146194	Field Blank	—	—	—	—	—	—	—	< 0.07 µg
146195	Field Blank	—	—	—	< 4 µg	< 4 µg	N/A	< 4 µg	—

TABLE 6

AIR SAMPLING RESULTS
DYNAMIC STRIPPING STEAM INJECTION OPERATIONS

Date: June 2, 1993

Sample No.	Employee Name/No.	Task	Time (min.)	Volume (liters)	Result (parts per million, ppm)				
					Benzene	Toluene	Ethyl benzene	Xylenes	Ethylene Dibromide
146200	Bunsen Nie 40A043	Sampled vapor from ICE Inlet and Outlet, Vapor Condensation System (TFF-MEGA-HC) and Holding Tank #2	50	9.8	—	—	—	—	<0.09 ppb
146201			50	2.5	—	—	—	—	0.3 ppb
146198			50	9.8	<0.1	<0.1	N/A	<0.1	—
146199			50	2.6	<0.5	<0.4	N/A	<0.3	—
146194	Field Blank	—	—	—	—	—	—	—	< 0.07 µg
146195	Field Blank	—	—	—	< 4 µg	< 4 µg	N/A	< 4 µg	—

TABLE 7

AIR SAMPLING RESULTS
DYNAMIC STRIPPING STEAM INJECTION OPERATIONS

Date: June 11, 1993

Sample No.	Employee Name/No.	Task	Time (min.)	Volume (liters)	Result (parts per million, ppm)				
					Benzene	Toluene	Ethyl benzene	Xylenes	Ethylene Dibromide
146186	Allen Van Noy/ 915062	Change-out of 5 µm Cuno Filters for Water Treatment System	30	6.0	<0.2	<0.4	<0.4	<0.4	—
146187			30	2.0	N/A	N/A	N/A	N/A	—
146189	Ben Johnson 443784	Routine Gas Pad Operations (morning)	195	39	<0.03	<0.07	<0.06	<0.06	—
146190			195	10	N/A	N/A	N/A	N/A	—
146191		Routine Gas Pad Operations (afternoon)	168	37	<0.03	<0.07	<0.06	<0.06	—
146192			168	6.7	N/A	N/A	N/A	N/A	—
146188	Field Blank		—	—	<3 µg	<10 µg	<10 µg	<10 µg	—

TABLE 8

AIR SAMPLING RESULTS
DYNAMIC STRIPPING STEAM INJECTION OPERATIONS

Date: June 17, 1993

Sample No.	Employee Name/No.	Task	Time (min.)	Volume (liters)	Result (parts per million, ppm)				
					Benzene	Toluene	Ethyl benzene	Xylenes	Ethylene Dibromide
146249	Bunsen Nie 40A043	Routine vapor and liquid sampling (morning)	180	36	<0.03	<0.07	<0.06	0.13	—
146250			180	36	—	—	—	—	0.4 ppb
146253		Routine vapor and liquid sampling (afternoon)	210	42	<0.02	<0.06	<0.06	0.08	—
146254			210	42	—	—	—	—	0.06 ppb
146251	Ben Johnson 443784	Routine Gas Pad Operations (morning)	180	36	<0.03	<0.07	<0.06	0.06	—
146252			180	22	—	—	—	—	< 0.4 ppb
146255		Routine Gas Pad Operations (afternoon)	210	42	<0.02	<0.06	<0.06	0.13	—
146156			210	42	—	—	—	—	0.08 ppb
146257	Bunsen Nie 40A043	Collected VOA samples from Megator	15	3.0	<0.02	<0.3	<0.9	<0.8	—
146258			15	3.0	—	—	—	—	5.6 ppb
146259	Field Blank		—	—	<3 µg	<10 µg	<10 µg	<10 µg	—

TABLE 9

AIR SAMPLING RESULTS
DYNAMIC STRIPPING STEAM INJECTION OPERATIONS

Date: June 24, 1993

Sample No.	Employee Name/No.	Task	Time (min.)	Volume (liters)	Result (parts per million, ppm)				
					Benzene	Toluene	Ethyl benzene	Xylenes	Ethylene Dibromide
146260	Bunsen Nie 40A043	Routine vapor and liquid sampling (morning)	180	36	< 0.02	< 0.07	< 0.06	< 0.06	—
146261			180	36	—	—	—	—	0.08 ppb
146264		Routine vapor and liquid sampling (afternoon)	255	51	< 0.02	< 0.05	< 0.05	0.1	—
146265			255	51	—	—	—	—	0.08 ppb
146262	Ben Johnson 443784	Routine Gas Pad Operations (morning)	180	36	<0.03	<0.07	<0.06	<0.06	—
146263			180	36	—	—	—	—	0.1 ppb
146266		Routine Gas Pad Operations (afternoon)	255	51	< 0.02	< 0.05	< 0.05	< 0.07	—
146167			255	51	—	—	—	—	< 0.05 ppb
146168	Field Blank		—	—	<3 µg	<10 µg	<10 µg	<10 µg	—
146169	Field Blank		—	—	—	—	—	—	< 0.02 µg

TABLE 10

OCCUPATIONAL STANDARDS AND GUIDELINES*

Reference	Benzene	Toluene	Ethyl benzene	Xylenes	Ethylene Dibromide	TCE	1,2-DCE
Federal Occupational Safety & Health Administration (OSHA)- Permissible Exposure Limit (PEL)	**1 ppm[1] TWA[2] and 5 ppm STEL[3]. Carcinogen**	200 ppm TWA[4]	**100 ppm TWA**	100 ppm TWA	20 ppm TWA[5]	100 ppm TWA[6]	50 ppm TWA[7]
American Conference of Governmental Industrial Hygienists (ACGIH) - Threshold Limit Value (TLV)	10 ppm[8] TWA - Suspected Human Carcinogen	**50 ppm TWA - Skin[9]**	100 ppm TWA	**100 ppm TWA - Skin**	**ALARA[10] - Suspected Human Carcinogen - Skin**	**50 ppm TWA and 200 ppm STEL[11]**	**10 ppm TWA**
State of California OSHA (CAL/OSHA) - PEL	1 ppm TWA and 5 ppm STEL - Skin - Carcinogen	100 ppm TWA and 150 ppm STEL - Skin[12]	100 ppm TWA and 125 ppm STEL	100 ppm TWA and 150 ppm STEL[13]	0.13 ppm TWA and Ceiling	25 ppm TWA and 200 ppm STEL[14]	1 ppm TWA and 2 ppm STEL[15]
National Institute of Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL)	0.1 ppm TWA and 1 ppm Ceiling for 15 min. - Carcinogen	100 ppm TWA and 150 ppm STEL	100 ppm TWA and 125 ppm STEL	100 ppm TWA and 150 ppm STEL	0.045 ppm TWA and 0.13 ppm Ceiling for 15 min. - Carcinogen	25 ppm TWA - Carcinogen	1 ppm TWA and 2 ppm STEL - Carcinogen

The most stringent mandated criteria is emboldened.

All footnotes are described on the next page.

* Fed/OSHA PEL and ACGIH TLV' compliance is currently mandated by DOE Order 5480.10. Cal/OSHA PEL's are not currently mandated but are expected to be mandatory within the next several years. NIOSH RELs are shown as guideline information.

[1] ppm = parts per million

[2] TWA = 8-hour time-weighted-average

[3] STEL = Short-term Exposure Limit - Based on a 15 minute duration

[4] Fed/OSHA also has established a 300 ppm Ceiling Concentration for Toluene not to be exceeded at any time during an 8-hour shift except for an acceptable 500 ppm maximum peak concentration for no more than 10 minutes in an 8-hour shift.

[5] Fed/OSHA also has established a 30 ppm Ceiling Concentration for Ethylene Dibromide not to be exceeded at any time during an 8-hour shift except for an acceptable 50 ppm maximum peak concentration for no more than 5 minutes in an 8-hour shift.

[6] Fed/OSHA also has established a 200 ppm Ceiling Concentration for Trichloroethylene not to be exceeded at any time during an 8-hour shift except for an acceptable 300 ppm maximum peak concentration for no more than 5 minutes in any 2 hours.

[7] Fed/OSHA also has established a 100 ppm Ceiling Concentration for 1, 2-Dichloroethane (Ethylene Dichloride) not to be exceeded at any time during an 8-hour shift except for an acceptable 200 ppm maximum peak concentration for no more than 5 minutes in any 3 hours.

[8] **Intended change to 0.1 ppm TWA and listing as a Confirmed Human Carcinogen**

[9] Skin notation indicates a potential significant contribution to the overall exposure by the cutaneous route.

[10] ALARA = As Low As Reasonably Achievable

[11] Intended change to a 50 ppm TWA and a 100 ppm STEL.

[12] Cal/OSHA also has established a Ceiling Concentration of 500 ppm for Toluene not to be exceeded at any time.

[13] Cal/OSHA also has established a Ceiling Concentration of 300 ppm for Xylene not to be exceeded at any time.

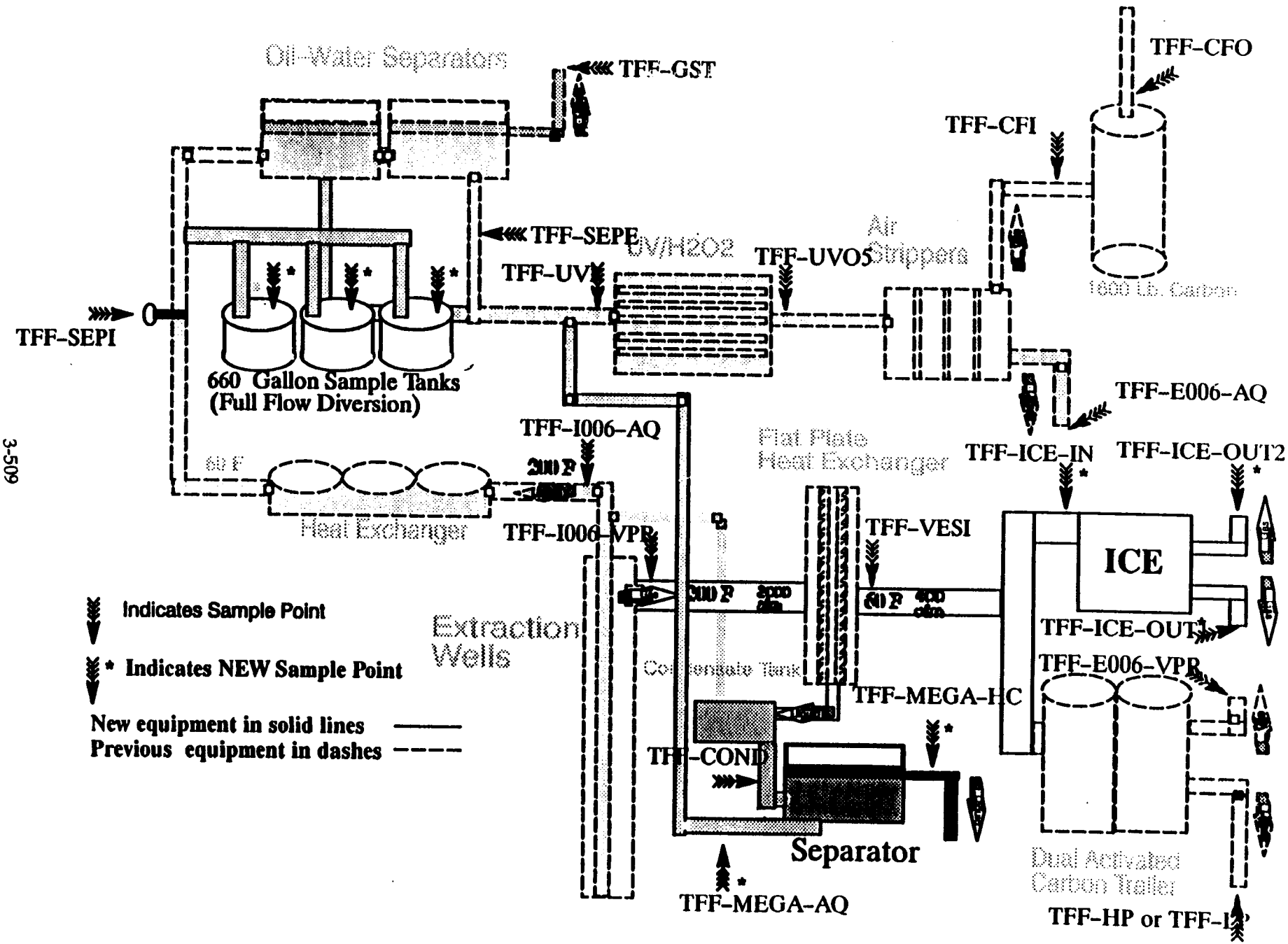
[14] Cal/OSHA also has established a Ceiling Concentration of 300 ppm for Trichloroethylene not to be exceeded at any time.

[15] Cal/OSHA also has established a Ceiling Concentration of 200 ppm for 1,2-Dichloroethane not to be exceeded at any time.

APPENDIX I

SCHEMATIC SYSTEMS FLOWCHART

Second Pass Modifications



APPENDIX II

LABORATORY ANALYTICAL REPORTS

LLNL HAZARDS CONTROL ANALYTICAL LABORATORY
ANALYSIS REPORT

MONDAY 06/14/93

SUBMITTER: SFRANASKE
FORM#: 20969
BUILDING#: 406

CASE: 794
DATE REC: 28-MAY-93
DATE COMPLETED: 11-JUN-93

HC LAB NOTES: *** CS2 LEAKED OUT OF DESORBED SAMPLES. NOT ANALYSED.

HC_SAMP#	FIELD#	TEST	RESULT	UNITS	ROOM#	LOCATION
9303925	146170	BENZENE	**	MG/M3		
	146170	TOLUENE	**	MG/M3		
	146170	XYLENE	**	MG/M3		
9303926	146171	BENZENE	<0.7	MG/M3		
	146171	TOLUENE	<0.7	MG/M3		
	146171	XYLENE	<0.7	MG/M3		
9303927	146172	BENZENE	<0.5	MG/M3		
	146172	TOLUENE	<0.5	MG/M3		
	146172	XYLENE	<0.5	MG/M3		
9303928	146173	BENZENE	<1.0	MG/M3		
	146173	TOLUENE	<1.0	MG/M3		
	146173	XYLENE	<1.0	MG/M3		
9303929	146174	BENZENE	**	MG/M3		
	146174	TOLUENE	**	MG/M3		
	146174	XYLENE	**	MG/M3		
9303930	146175	BENZENE	8.6	MG/M3		
	146175	TOLUENE	<4.3	MG/M3		
	146175	XYLENE	<4.3	MG/M3		

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

APPROVED BY R. SHAH

SUBMITTER: SFRAHASZE
FORM#: 20969
BUILDING#: 406

CASE: 794
DATE REC: 28-MAY-93
DATE_COMPLETED: 14-JUN-93

HC LAB NOTES: *** CS2 LEAKED OUT OF DESORBED SAMPLES. NOT ANALYSED.

HC_SAMP#	FIELD#	TEST	RESULT	UNITS	ROOM#	LOCATION
9303931	146176	BENZENE	<0.003	MG		
	146176	TOLUENE	<0.003	MG		
	146176	XYLENE	<0.003	MG		
9303932	146177	BENZENE	<0.8	MG/M3		
	146177	TOLUENE	<0.8	MG/M3		
	146177	XYLENE	<0.8	MG/M3		
9303933	146178	BENZENE	<1.7	MG/M3		
	146178	TOLUENE	<1.7	MG/M3		
	146178	XYLENE	<1.7	MG/M3		
9303934	146179	BENZENE	<0.4	MG/M3		
	146179	TOLUENE	<0.4	MG/M3		
	146179	XYLENE	<0.4	MG/M3		
9303935	146180	BENZENE	<0.7	MG/M3		
	146180	TOLUENE	<0.7	MG/M3		
	146180	XYLENE	<0.7	MG/M3		
9303936	146181	BENZENE	3.4	MG/M3		
	146181	TOLUENE	5.5	MG/M3		

APPROVED BY R. SHAH

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

MONDAY 06/14/93

LLNL HAZARDS CONTROL ANALYTICAL LABORATORY
ANALYSIS REPORT

SUBMITTER: SPRAMASER
FORM#: 20969
BUILDING#: 406

CASE: 794
DATE REC: 28-MAY-93
DATE COMPLETED: 14-JUN-93

HC LAB NOTES: *** CS2 LEAKED OUT OF DESORBED SAMPLES. NOT ANALYSED.

HC_SAMP#	FIELD#	TEST	RESULT	UNITS	ROOM#	LOCATION
9303936	146181	XYLENE	<0.8	MG/M3		
9303937	146182	BENZENE	<1.7	MG/M3		
	146182	TOLUENE	4.2	MG/M3		
	146182	XYLENE	<1.7	MG/M3		
9303938	146183	BENZENE	<0.003	MG		
	146183	TOLUENE	<0.003	MG		
	146183	XYLENE	<0.003	MG		
9303939	146184	BENZENE	<1.2	MG/M3		
	146184	TOLUENE	<1.2	MG/M3		
	146184	XYLENE	<1.2	MG/M3		
9303940	146185	BENZENE	<2.3	MG/M3		
	146185	TOLUENE	<2.3	MG/M3		
	146185	XYLENE	<2.3	MG/M3		

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

APPROVED BY R. SHAH

LLNL HAZARDS CONTROL ANALYTICAL LABORATORY
ANALYSIS REPORT

TUESDAY 06/22/93 PAGE 1

SUBMITTER: MCOSTELLA
FORM#: 21083
BUILDING#: 406

CASE: 823
DATE REC: 03-JUN-93
DATE COMPLETED: 21-JUN-93

HC LAB NOTES: ALL RESULTS ARE BLANK CORRECTED.

HC_SAMP#	FIELD#	TEST	RESULT	UNITS	ROOM#	LOCATION
9304004	146194	ETHYLENE DIBROMIDE	<0.07	UG		6/2
9304005	146200	ETHYLENE DIBROMIDE	<0.007	MG/M3		6/2P
9304006	146201	ETHYLENE DIBROMIDE	0.002	MG/M3		6/2P
9304007	146202	ETHYLENE DIBROMIDE	0.003	MG/M3		6/1P
9304008	146203	ETHYLENE DIBROMIDE	<0.025	MG/M3		6/1P
9304009	146206	ETHYLENE DIBROMIDE	<0.024	MG/M3		6/1A
9304010	146207	ETHYLENE DIBROMIDE	<0.099	MG/M3		6/1A
9304011	146210	ETHYLENE DIBROMIDE	0.022	MG/M3		6/1A
9304012	146211	ETHYLENE DIBROMIDE	<0.031	MG/M3		6/1A

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

APPROVED BY R. SHAH

LLNL HAZARDS CONTROL ANALYTICAL LABORATORY
ANALYSIS REPORT

TUESDAY 06/22/93 PAGE 1

SUBMITTER: MCOSTELLA
FORM#: 21083
BUILDING#: 406

CASE: 823
DATE REC: 03-JUN-93
DATE COMPLETED: 21-JUN-93

HC LAB NOTES: ALL RESULTS ARE BLANK CORRECTED.

HC_SAMP#	FIELD#	TEST	RESULT	UNITS	LOCATION
9304004	146194	ETHYLENE DIBROMIDE	<0.07	UG	6/2
9304005	146200	ETHYLENE DIBROMIDE	<0.007	MG/M3	6/2P
9304006	146201	ETHYLENE DIBROMIDE	0.002	MG/M3	6/2P
9304007	146202	ETHYLENE DIBROMIDE	0.003	MG/M3	6/1P
9304008	146203	ETHYLENE DIBROMIDE	<0.025	MG/M3	6/1P
9304009	146206	ETHYLENE DIBROMIDE	<0.024	MG/M3	6/1A
9304010	146207	ETHYLENE DIBROMIDE	<0.099	MG/M3	6/1A
9304011	146210	ETHYLENE DIBROMIDE	0.022	MG/M3	6/1A
9304012	146211	ETHYLENE DIBROMIDE	<0.031	MG/M3	6/1A

APPROVED BY R. SHAH

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

MONDAY 06/14/93

LLNL HAZARDS CONTROL ANALYTICAL LABORATC
ANALYSIS REPORT

SUBMITTER: MCOSTELLA
FORM#: 21082
BUILDING#: 406

CASE: 822
DATE REC: 03-JUN-93
DATE COMPLETED: 14-JUN-93

HC LAB NOTES:

HC SMP#	FIELD#	TEST	RESULT	UNITS	LOCATION
9303995	146195	BENZENE	<0.004	MG	
	146195	TOLUENE	<0.004	MG	
	146195	XYLENE	<0.004	MG	
9303996	146198	BENZENE	<0.4	MG/M3	6/2P
	146198	TOLUENE	<0.4	MG/M3	6/2P
	146198	XYLENE	<0.4	MG/M3	6/2P
9303997	146199	BENZENE	<1.5	MG/M3	6/2P
	146199	TOLUENE	<1.5	MG/M3	6/2P
	146199	XYLENE	<1.5	MG/M3	6/2P
9303998	146204	BENZENE	<0.3	MG/M3	6/1P
	146204	TOLUENE	<0.3	MG/M3	6/1P
	146204	XYLENE	<0.3	MG/M3	6/1P
9303999	146205	BENZENE	<1.4	MG/M3	6/1P
	146205	TOLUENE	<1.4	MG/M3	6/1P
	146205	XYLENE	<1.4	MG/M3	6/1P
9304000	146208	BENZENE	<1.5	MG/M3	6/1A
	146208	TOLUENE	<1.5	MG/M3	6/1A
	146208	XYLENE	<1.5	MG/M3	6/1A

APPROVED BY R. SHAH

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

LLNL HAZARDS CONTROL ANALYTICAL LABORATORY
ANALYSIS REPORT

MONDAY 06/14/93

SUBMITTER: MCOSTELLA
FORM#: 21082
BUILDING#: 406

CASE: 822
DATE REC: 03-JUN-93
DATE COMPLETED: 14-JUN-93

HC LAB NOTES:

HC_SAMP#	FIELD#	TEST	RESULT	UNITS	ROOM#	LOCATION
9304001	146209	BENZENE	<5.4	MG/M3		6/1A
	146209	TOLUENE	<5.4	MG/M3		6/1A
	146209	XYLENE	<5.4	MG/M3		6/1A
9304002	146212	BENZENE	<0.5	MG/M3		6/1A
	146212	TOLUENE	<0.5	MG/M3		6/1A
	146212	XYLENE	<0.5	MG/M3		6/1A
9304003	146213	BENZENE	<1.8	MG/M3		6/1A
	146213	TOLUENE	<1.8	MG/M3		6/1A
	146213	XYLENE	<1.8	MG/M3		6/1A

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

APPROVED BY R. SHAH

FRIDAY 07/02/93

LLNL HAZARDS CONTROL ANALYTICAL LABORATORY
ANALYSIS REPORT

SUBMITTER: SFRANASZE
FORM#: 21277
BUILDING#: 406

CASE: 873
DATE_REC: 14-JUN-93
DATE_COMPLETED: 02-JUL-93

HC LAB NOTES: NA= SECONDARY SAMPLES NOT ANALYZED

HC_SAMP#	FIELD#	TEST	RESULT	UNITS	ROOM#	LOCATION
9304164	146186	BENZENE	<0.50	MG/M3		
	146186	ETHYL BENZENE	<1.67	MG/M3		
	146186	TOLUENE	<1.67	MG/M3		
	146186	XYLENE	<1.67	MG/M3		
9304165	146187	BENZENE	NA			
	146187	ETHYL BENZENE	NA			
	146187	TOLUENE	NA			
	146187	XYLENE	NA			
9304166	146188	BENZENE	<0.003	MG		
	146188	ETHYL BENZENE	<0.01	MG		
	146188	TOLUENE	<0.01	MG		
	146188	XYLENE	<0.01	MG		
9304167	146189	BENZENE	<0.08	MG/M3		
	146189	ETHYL BENZENE	<0.26	MG/M3		
	146189	TOLUENE	<0.26	MG/M3		
	146189	XYLENE	<0.26	MG/M3		
9304168	146190	BENZENE	NA			
	146190	ETHYL BENZENE	NA			

APPROVED BY R. SHAH

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

SUBMITTER: SFRANASZE
FORM#: 21277
BUILDING#: 406

CASE: 873
DATE_REC: 14-JUN-93
DATE_COMPLETED: 02-JUL-93

HC LAB NOTES: NA= SECONDARY SAMPLES NOT ANALYZED

HC_SAMP#	FIELD#	TEST	RESULT	UNITS	ROOM#	LOCATION
9304168	146190	TOLUENE	NA			
	146190	XYLENE	NA			
9304169	146191	BENZENE	<0.08	MG/M3		
	146191	ETHYL BENZENE	<0.27	MG/M3		
	146191	TOLUENE	<0.27	MG/M3		
	146191	XYLENE	<0.27	MG/M3		
9304170	146192	BENZENE	NA			
	146192	ETHYL BENZENE	NA			
	146192	TOLUENE	NA			
	146192	XYLENE	NA			

APPROVED BY R. SHAH

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

LLNL HAZARDS CONTROL ANALYTICAL LABORATORY
ANALYSIS REPORT

TUESDAY 07/06/93

SUBMITTER: JMARTIN
FORM#: 21433
BUILDING#: 406

CASE: 906
DATE_REC: 18-JUN-93
DATE_COMPLETED: 02-JUL-93

HC LAB NOTES:

HC_SAMP#	FIELD#	TEST	RESULT	UNITS	ROOM#	LOCATION
9304438	146249	BENZENE	<0.08	MG/M3		
	146249	ETHYL BENZENE	<0.28	MG/M3		
	146249	TOLUENE	<0.28	MG/M3		
	146249	XYLENE	0.56	MG/M3		
9304439	146250	ETHYLENE DIBROMIDE	0.003	MG/M3		
9304440	146251	BENZENE	<0.08	MG/M3		
	146251	ETHYL BENZENE	<0.28	MG/M3		
	146251	TOLUENE	<0.28	MG/M3		
	146251	XYLENE	0.27	MG/M3		
9304441	146252	ETHYLENE DIBROMIDE	<0.003	MG/M3		

APPROVED BY R. SHAH

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

TUESDAY 07/06/93

LLNL HAZARDS CONTROL ANALYTICAL LABORATORY
ANALYSIS REPORT

SUBMITTER: JMARTIN
FORM#: 21439
BUILDING#: TFF

CASE: 907
DATE REC: 18-JUN-93
DATE_COMPLETED: 02-JUL-93

HC LAB NOTES: * 9304447 RESULT IS FROM BACK OF THE TUBE. FRONT WAS BELOW DETECTION LIMIT.

HC_SAMP#	FIELD#	TEST	RESULT	UNITS	ROOM#	LOCATION
9304442	146253	BENZENE	<0.07	MG/M3		
	146253	ETHYL BENZENE	<0.24	MG/M3		
	146253	TOLUENE	<0.24	MG/M3		
	146253	XYLENE	0.37	MG/M3		
9304443	146254	ETHYLENE DIBROMIDE	0.0005	MG/M3		
9304444	146255	BENZENE	<0.07	MG/M3		
	146255	ETHYL BENZENE	<0.24	MG/M3		
	146255	TOLUENE	<0.24	MG/M3		
	146255	XYLENE	0.58	MG/M3		
9304445	146256	ETHYLENE DIBROMIDE	0.0006	MG/M3		
9304446	146257	BENZENE	<1.00	MG/M3		
	146257	ETHYL BENZENE	<3.33	MG/M3		
	146257	TOLUENE	<3.33	MG/M3		
	146257	XYLENE	<3.33	MG/M3		
9304447	146258	ETHYLENE DIBROMIDE	0.043*	MG/M3		
9304448	146259	BENZENE	<0.003	MG		
	146259	ETHYL BENZENE	<0.01	MG		

APPROVED BY R. SHAH

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

LLNL HAZARDS CONTROL ANALYTICAL LABORATORY
ANALYSIS REPORT

SUBMITTER: JMARTIN
FORM#: 21439
BUILDING#: TFF

CASE: 907
DATE_REC: 18-JUN-93
DATE_COMPLETED: 02-JUL-93

HC LAB NOTES: * 9304447 RESULT IS FROM BACK OF THE TUBE. FRONT WAS BELOW DETECTION LIMIT.

HC_SAMP#	FIELD#	TEST	RESULT	UNITS	ROOM#	LOCATION
9304448	146259	TOLUENE	<0.01	MG		
	146259	XYLENE	<0.01	MG		

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RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

LLNL HAZARDS CONTROL ANALYTICAL LABORATORY
ANALYSIS REPORT

TUESDAY 07/06/93

SUBMITTER: JMARTIN
FORM#: 21557
BUILDING#: TFF

CASE: 946
DATE REC: 28-JUN-93
DATE_COMPLETED: 02-JUL-93

HC LAB NOTES:

HC_SAMP#	FIELD#	TEST	RESULT	UNITS	ROOM#	LOCATION
9304704	146262	BENZENE	<0.08	MG/M3		
	146262	ETHYL BENZENE	<0.28	MG/M3		
	146262	TOLUENE	<0.28	MG/M3		
	146262	XYLENE	0.27	MG/M3		

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APPROVED BY R. SHAH

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

FRIDAY 07/09/93

LLNL HAZARDS CONTROL ANALYTICAL LABORATORY
ANALYSIS REPORT

SUBMITTER: JMARTIN
FORM#: 21558
BUILDING#: ITT

CASE: 947
DATE SAMPLED:
DATE REC: 28-JUN-93
DATE COMPLETED: 08-JUL-93

EC LAB NOTES:

EC_RAMP#	FIELD#	TEST	RESULT	UNITS	BOOM#	LOCATION
9304705	146263	ETHYLENE DIBROMIDE	0.0008	MG/M3		
9304706	146264	BENZENE	<0.06	MG/M3		
	146264	ETHYL BENZENE	<0.20	MG/M3		
	146264	TOLUENE	<0.20	MG/M3		
	146264	XYLENE	0.46	MG/M3		
9304707	146265	ETHYLENE DIBROMIDE	0.0006	MG/M3		
9304708	146266	BENZENE	<0.06	MG/M3		
	146266	ETHYL BENZENE	<0.20	MG/M3		
	146266	TOLUENE	<0.20	MG/M3		
	146266	XYLENE	0.33	MG/M3		
9304709	146267	ETHYLENE DIBROMIDE	<.0004	MG/M3		
9304710	146268	BENZENE	<0.003	MG		
	146268	ETHYL BENZENE	<0.01	MG		
	146268	TOLUENE	<0.01	MG		
	146268	XYLENE	<0.01	MG		
9304711	146269	ETHYLENE DIBROMIDE	<.00002	MG		

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY

APPROVED BY R. SHAH

LLNL HAZARDS CONTROL ANALYTICAL LABORATORY
ANALYSIS REPORT

FRIDAY 07/09/93

SUBMITTER: JMARTIN
FORM#: 21556
BUILDING#: TFF

CASE: 945
DATE SAMPLED:
DATE RECEIVED: 28-JUN-93
DATE COMPLETED: 02-JUL-93

HC LAB NOTES:

HC_SAMP#	FIELD#	TEST	RESULT	UNITS	ROOM#	LOCATION
9304702	146260	BENZENE	<0.08	MG/M3		
	146260	ETHYL BENZENE	<0.28	MG/M3		
	146260	TOLUENE	<0.28	MG/M3		
	146260	XYLENE	<0.28	MG/M3		
9304703	146261	ETHYLENE DIBROMIDE	0.0006	MG/M3		

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APPROVED BY R. SHAH

RESULTS VALID FOR INDUSTRIAL HYGIENE USE ONLY